Necessity of Plug-In Hybrid Electric Vehicle and Their Influence on Power System

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Abstract -- The atmosphere in present world is much polluted and it will become worse. The reasons behind this condition is greenhouse gases, CO2, and burning of fossil fuels. Transportation system plays a major role for these environmental conditions. As the population increases, the number of vehicle increases and so pollution. Hence, an alternative solution to this problem is plug-in hybrid electric vehicle (PHEVs). Due to various advantages of PHEV like emission reduction, cost saving, vehicle to grid concept, and moving energy source, we feel the necessity of PHEV. But with advantages there are some challenges also like PHEVs need charging and it increases the load on the grid, affects the peak load demand and voltage profile. This paper discusses about the need of PHEV and its effect on the distribution grid also the integration of renewable energy sources (RES) with grid and PHEVs. Also a brief about the V2G technology used to increase the overall efficiency of the system.

Index Words—Power Distribution Grid, Plug-in Hybrid Electric Vehicle (PHEV), Renewable Energy Sources (RES), Battery, V2G Technology, Smart Grid, Emission, On-peak Load, Off-peak Load.

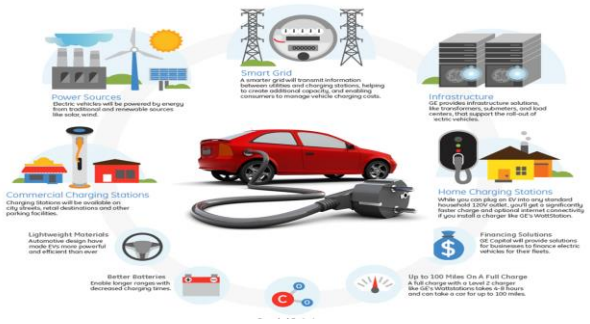
I. INTRODUCTION

Plug-in hybrid electric vehicle (PHEVs) is a concept of charging the vehicle from on-board electricity generation or plugging into electric outlet [1]. When the battery of the vehicle is charged from any external electric means then it becomes a plug-in hybrid electric vehicle. Here, the term hybrid means compound of two or more energy sources like fossil fuel and electricity in the PHEV case. In simple language, the vehicle is running on two sources instantly either on fossil fuel (petrol, diesel) or on electricity (battery storage). The plug-in hybrid electric vehicle is an advanced version of battery electric vehicle (BEVs) and hybrid electric vehicle (HEVs). The main two reasons for the existence or introduction of plug-in hybrid vehicle-

a. The fossil fuels are non-renewable in nature and take a long time to regenerate. The amount of these fuels is depleting at a high rate. Hence, to overcome this kind of problem we requires an alternative method for transportation and one of the best option is electricity. Although, the range of electric vehicle is less but it is acceptable by using various measures.
b. The pollution in the environment is increasing every day. This pollution is cause mainly from emission of the gases from the generating units, transportation vehicles, etc. The two mentioned have a common reason that is burning of the fossil fuel. Now to reduce this harmful emission we are using electricity in transportation. A PHEV uses electricity which gives zero emission.

The various advantages of PHEVs provided a head start to the business. Few advantages are as follows-

It is alternative to the fossil fuels, it is free from the emission of polluting gases, the concept of V2G technology is very useful, integration of the renewable energy sources with PHEVs.



Although it have many advantages but it also impacts on our grid system. The challenges of PHEVs are discussed below.

II. PROBLEM ANALYSIS

Our transmission and distribution system is now improving and becoming interconnected system by the use of FACTs devices and smart grid technologies. The voltage profile at user end must be reasonably good and reliable. But the overload condition reduces the power quality of the distribution grid. Hence, here encounters a major problem for PHEV connection with the grid. The PHEV is added as load, which significantly increases the overall residential load. This leads to the problem of the overload condition and poor power quality. The solution to this problem is coordinate charging which is explained later in this paper.

The problem of overload is mainly due to the unplanned charging of PHEV that means the user connects the vehicle and start charging immediately when their vehicle is discharged no matter may be on-peak time or off-peak load time. Hence, when it connected in on-peak time then the condition of overload arises and may cause severe damage to the grid system.

III. COORDINATED CHARGING

The planned charging is termed as coordinate charging. It is a solution to the overload condition arises on distribution grid. In coordinate or planned concept the users are advised to charge the vehicle in off-peak period time mainly at night because in this period the load on the grid is base load. One more way to aware the people about coordinate charging is tariff. The tariff is less on off-peak time as compare to peak load time or government should use smart metering system. One another way is that the supply timing should b scheduled and through means of communication user get information about the charging timings. The PHEV is able to communicate with the following as shown in figure-

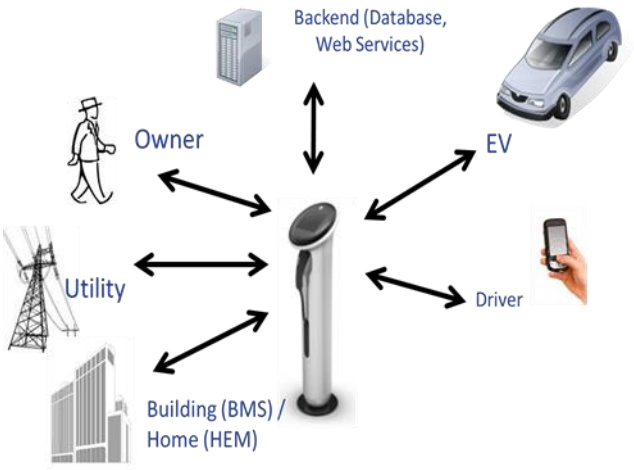


Figure2: Communication

IV. RENEWABLE SOURCES INTEGRTAION

As discussed above, the problem on grid may be solved by coordinate charging up to an extent, one more alternative is renewable sources like the sun and wind. As we know that the sun and wind both are free sources of energy. One can use them to supply the extra load added on the grid due to the PHEVs. This is very beneficial, these sources can supply directly to the grid and used for various purposes. Although it is costly and the efficiency depends on various factors but it helps in saving the environment and fossil fuels. For solar and wind integration a block diagram is represented below-

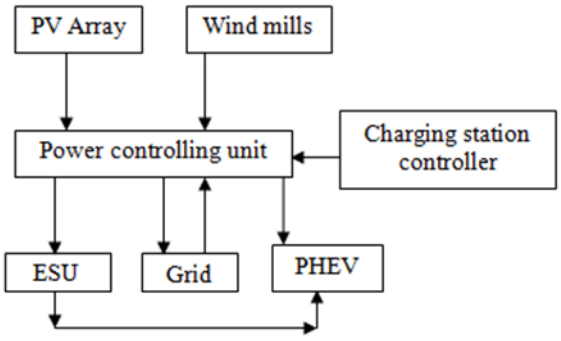


Figure 3: Integration of Renewable sources

V. V2G TECHNOLOGY

A V2G technology stands for vehicle to grid. As the name explains the power flows from vehicle to grid when needed. As the PHEV uses large storage batteries with higher capacity, firstly they charged during off-peak period and can support the grid by supplying the energy to the grid or directly to the commercial buildings or residential areas. Hence, this upcoming technology is very useful and reduces the chances for power outages.

VI. ADVANTAGES

- Alternative used in place of fossil fuels
- Reduces the emission and save the environment
- Can supply grid hence, chances of power failure is reduced
- Integration with renewable sources

VII. LIMITATIONS

- The cost of the large batteries is high
- Range covered by vehicle is less
- Overloading on distribution grid

VIII. CONCLUSION

In general, the PHEV is very useful due to its various advantages over the other transportation types. It eliminates the emission problem, reduces the chances of power failure. It also impacts on the grid by overloading the grid during the uncoordinated charging. The solution to this may be coordinate charging and use of renewable sources. This technology may extend to other objective functions, such as reactive power control, voltage profile improvement and distributed supply system.

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